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A GRAPHIC METHOD OF CORRELATING FISH ENVIRONMENT AND DISTRIBUTION

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IT is some years since ornithologists saw the advantages of a graphic means of representing complex bird waves and their coincident relation to physical conditions. In ichthyology a schematic method whereby fish distribution and environment can be correlated is not less valuable.

The study of a stream and its fishes involves the consideration of factors so numerous and so diverse, and accumulates such a mass of data, that one is impelled to adopt some graphic method to make results appear quickly and clearly.

The chart to be described presently (Fig. 1) is of a hypothetic stream, including a variety of possible conditions. The first continuous vertical line to the right of the list of species represents the mouth of the stream, and the corresponding vertical on the right of the chart is its source. The dotted verticals numbered below (1–8) mark mile points. Beneath the "Misc. Data" space, these mile lines are not dotted but continuous.

The heavy horizontal opposite each species indicates the range of that species in the stream. Wherever the horizontal is broken, it indicates the occasional occurrence of the species. Whenever a species gains entrance to a stream from two or more points an arrow tip at the end of each of its range lines indicates the direction of its migration; *e. g.*, in our hypothetic stream the carp, *Cyprinus carpio* enters from the mouth and from canal overflows.

The continuous horizontal above the first species in the list, represents the surface of the water. The bottom is shown by the curved line labeled "Bottom of Stream." The average depth at any given point is, therefore, the vertical between these two lines, read from the scale at the extreme right of the chart.

The continuous horizontal immediately below the last species enumerated, represents the altitude of the mouth above sea-level. The profile line indicates the drop in the stream. The approximate altitude of any given point along the stream is shown by the vertical between the two above mentioned lines, and read from the scale at the right.

The continuous horizontal in "Valley Cross Sections" represents the stream, on either side of which is shown a section of the country for one and a quarter miles. In these cross sections at every mile point the geologic formation can be indicated.

The current, width and bottom data are self explanatory. In the "Miscellaneous Data," bridges, marshy regions, dams, etc., are represented so far as possible, by the conventional signs employed by the U. S. Geological Survey, thus:

Bridges.............(A)	*e. g.*,	below the one mile mark, at the two mile mark, etc.
Woodlands.........(B)	"	at the one mile mark.
Swamp.............(C)	"	between the one and two mile marks.
Important Tributary (D)		represented by a forked wavy line. The position of the tributary line in the upper or lower part of the "Misc. Data" space indicates that the tributary enters the stream from the right or left side respectively.
	"	at the 1.25 mile mark. (Enters from the left side.)
	"	at the 2.6 mile mark. (Enters from the right side.)
Falls...............(E)	"	on either side of the four mile mark.
Dams...............(F)	"	at the 5.6 mile mark.
Remains of a Dam..(G)	"	at the seven mile mark.
Small Tributary.... (H)		represented by an unforked wavy line.
	"	at the 5.8 mile mark. (Enters from the right side.)

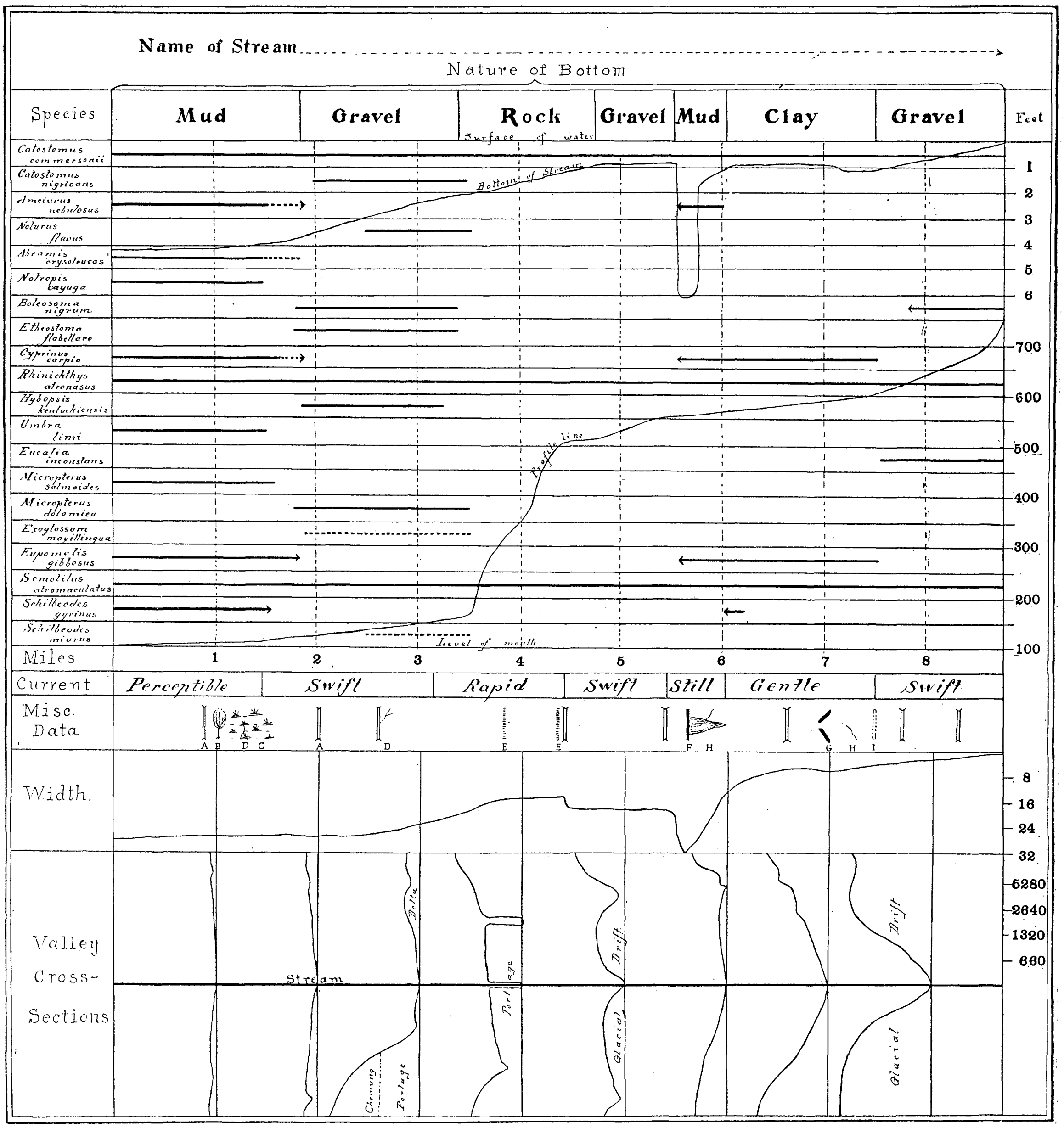

FIG. 1.— A Hypothetic Chart Correlating Fish Environment and Distribution.

Explanation of Miscellaneous Data.

A......Bridge.
B......Woodlands.
C......Swamp.
D......Important Tributary.
E......Falls.
F......Dam.
G......Remains of a Dam.
H......Small Tributary.
I......Canal.

e. g., at the 7.25 mile mark. (Enters from the left side.)
Canal..............(I) " at the 7.5 mile mark.

Taking the common bullhead, *Ameiurus nebulosus,* as an example, one is able to read from the chart, concerning its distribution, etc., the following: it is common in the lower two miles of the stream, gradually decreasing in abundance at the end of the second mile. Throughout the middle course where rock or gravel bottoms and swift water or rapids occur this species is absent. In the upper course where the current and bottom are influenced by the dam, located 5.5 miles from the mouth, it reappears. In the latter instance, its presence so near the headwaters is due to canal overflows at the 7.5 mile point. It seldom frequents water less than 4 feet deep. In both ranges, the drop in the stream is slight, so that the current is just perceptible at the mouth, and imperceptible at the dam. At these two points the stream's width is respectively 27 and 32 feet. In both places a muddy bottom obtains. In the lower course the stream lies on a delta formation while in the upper course the underlying stratum is glacial drift.

The Johnny darter, *Boleosoma nigrum,* occurs at the source of the creek, due to a contribution at floodtime from another stream across the divide, the two sources being on the same level and continuous at some seasons. The falls on either side of the 4 mile point would preclude its reaching the source from the mouth.

One objection to the chart, which appears serious at first, is its failure to show migration within the stream. If a stream, however, be charted in this way in the spring, summer and autumn and a comparison of the three charts be made, many interesting deductions might be drawn. Should it seem desirable to make the work more intensive, to restrict it to a limited portion of a stream and to a single species, daily surveys might be made and the results embodied in one chart. The date of each daily survey could be placed in the spaces now occupied by the specific names and the range line for the day constructed opposite the date.

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